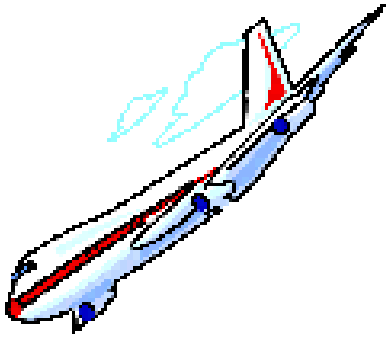


CHAPTER 8

MOTION

Motion is defined as the change in position of body with time.

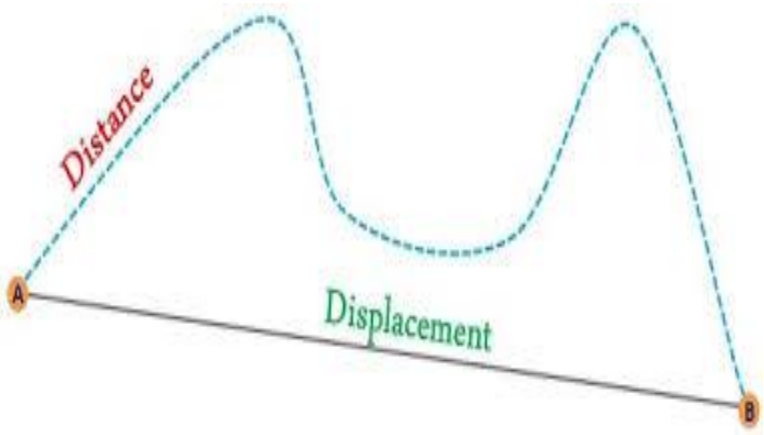
- To describe the position (location) of an object we need to specify a reference point called the origin.
- Let us assume that a school in a village is 2 km north of the railway station. We have specified the position of the school with respect to the railway station. In this example, the railway station is the reference point. We could have also chosen other reference points according to our convenience.

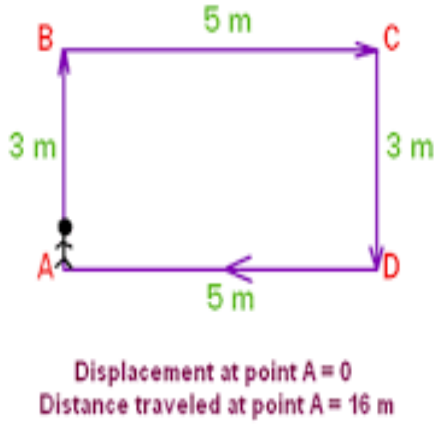
Uniform and non Uniform motion

- Uniform Motion- If a body travels equal distance in equal intervals of time then it is in uniform motion
- Non-uniform motion- If a body travels unequal distance in equal intervals of time then it is in uniform motion

Distance and Displacement

- Distance= the total path length covered by an object from the initial position to the final position .
- Displacement= The shortest distance between the initial and the final position.





Measuring the Rate of Motion- Different objects may take different amounts of time to cover a given distance. Some of them move fast and some move slowly. One of the ways of measuring the rate of motion of an object is to find out the distance travelled by the object in unit time. This quantity is referred to as speed.

Speed=Distance/Time

Average Speed =total distance travelled/Total time taken

Velocity

The rate of motion is more meaningful if we specify if we specify its direction of motion with speed, which is termed as velocity.

It is a vector quantity.

Velocity=Dispalcement/Time

Average velocity= Total Dispalcement/Total Time

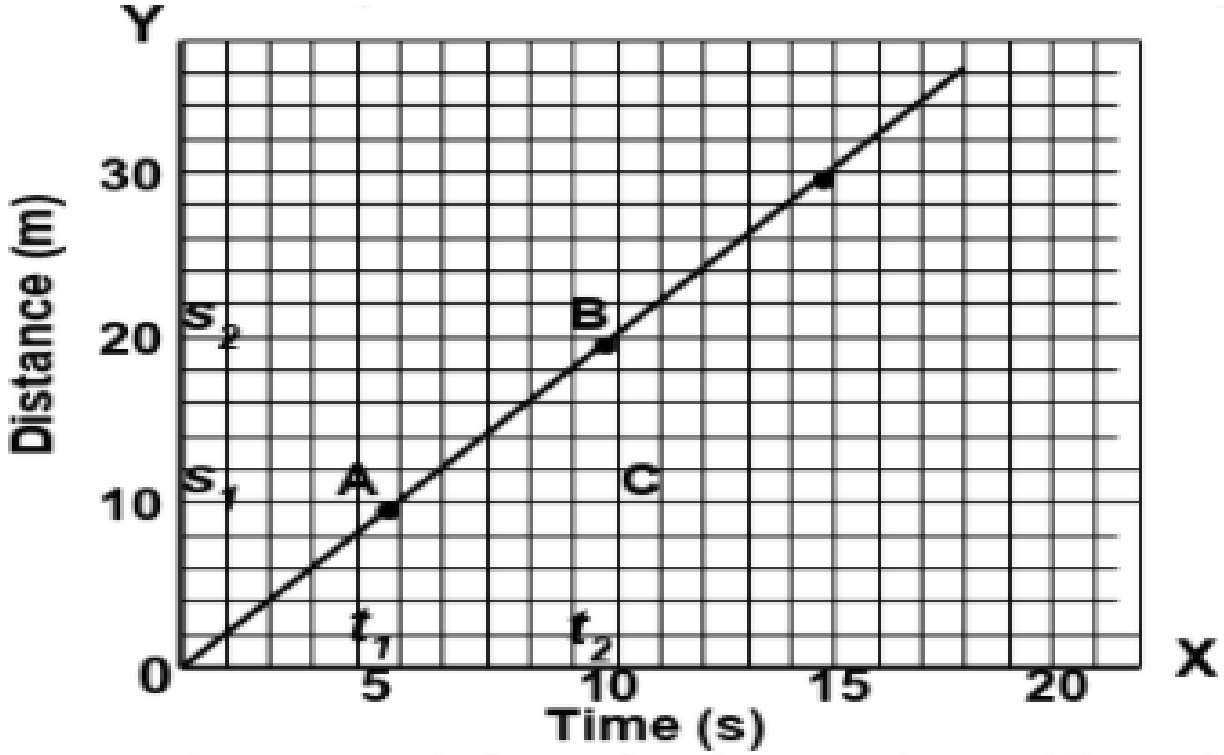
=v+u/2

Acceleration

- The rate of change of velocity is termed as acceleration. (During non-uniform motion)
- Acceleration =a=v-u/t
- Its SI unit is m/s2
- Uniform acceleration-When the change in velocity is equal in equal intervals of time.
- Non-Uniform acceleration-When the change in velocity is unequal in equal intervals of time.

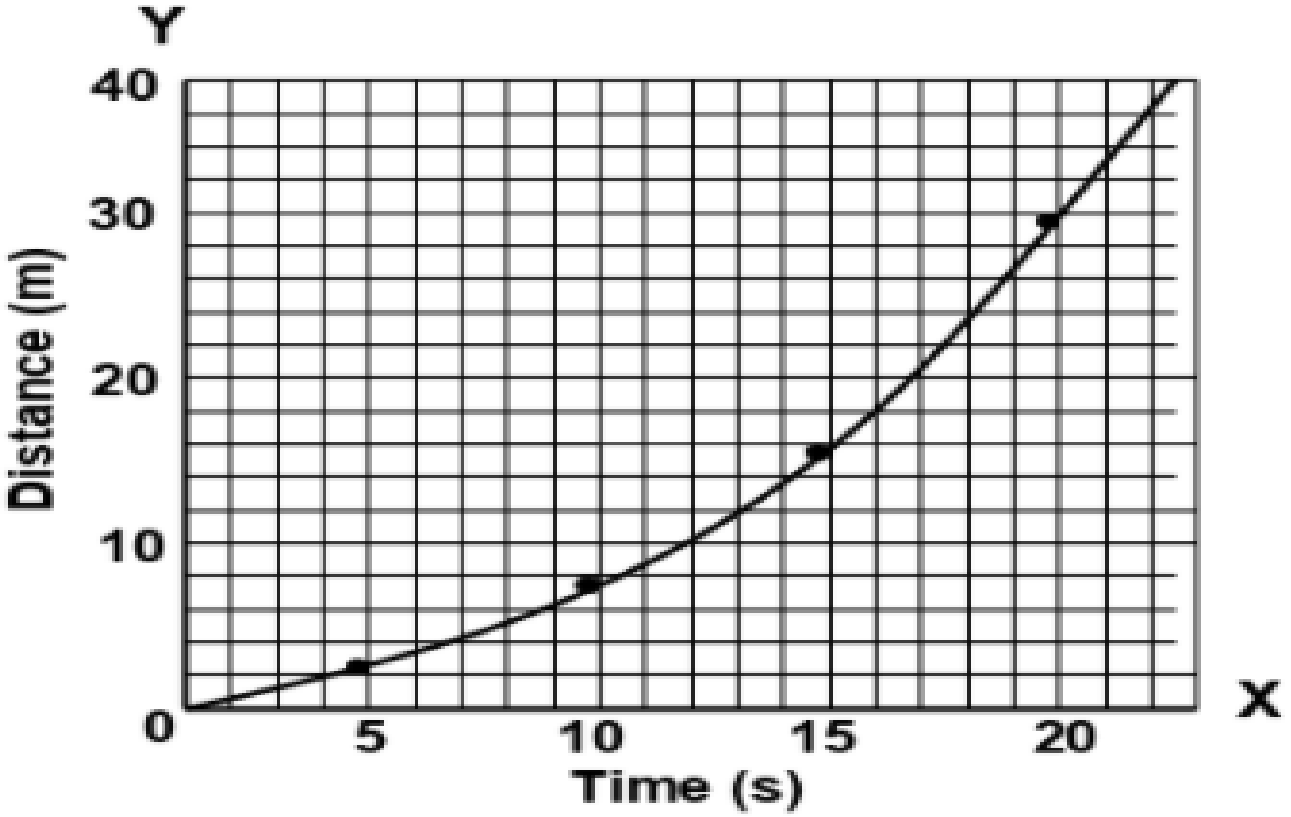
Distance time graphs

- For a body moving in uniform motion



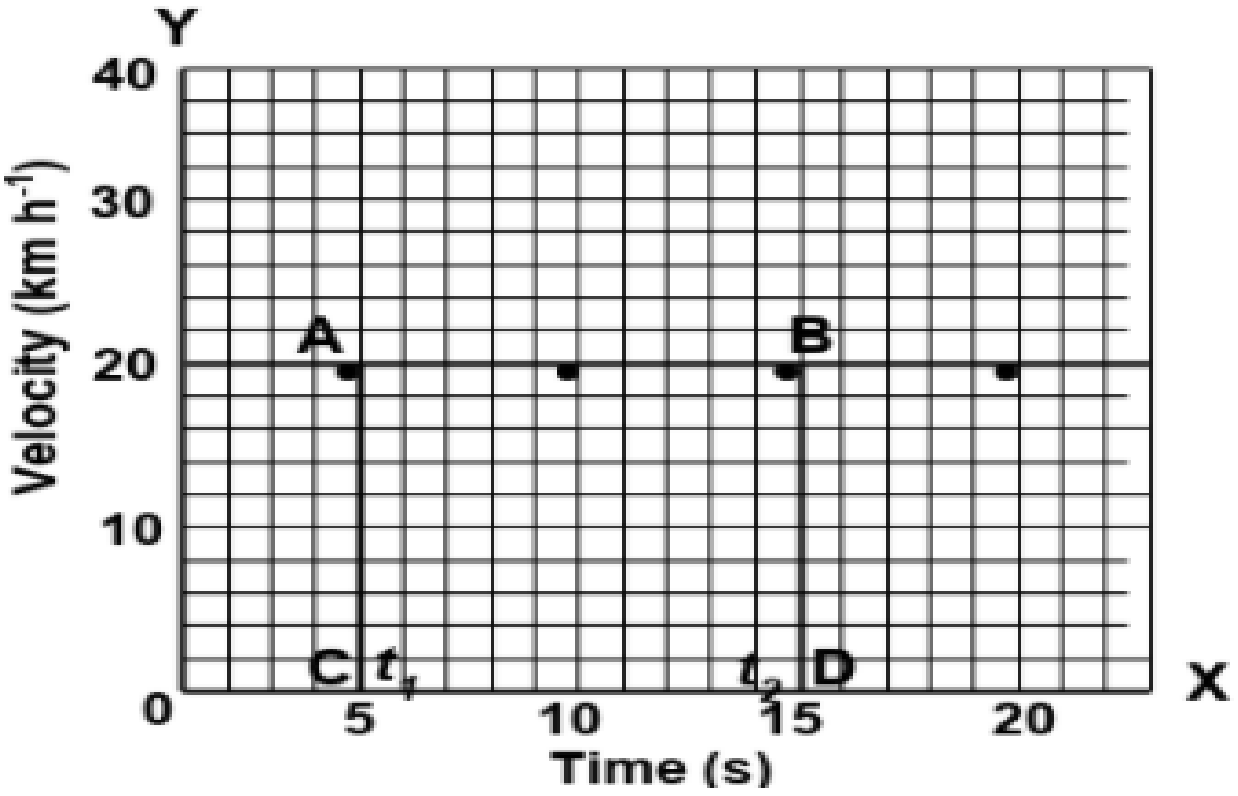
Distance – time graph for a body moving with uniform speed

- For a body moving with non-uniform speed

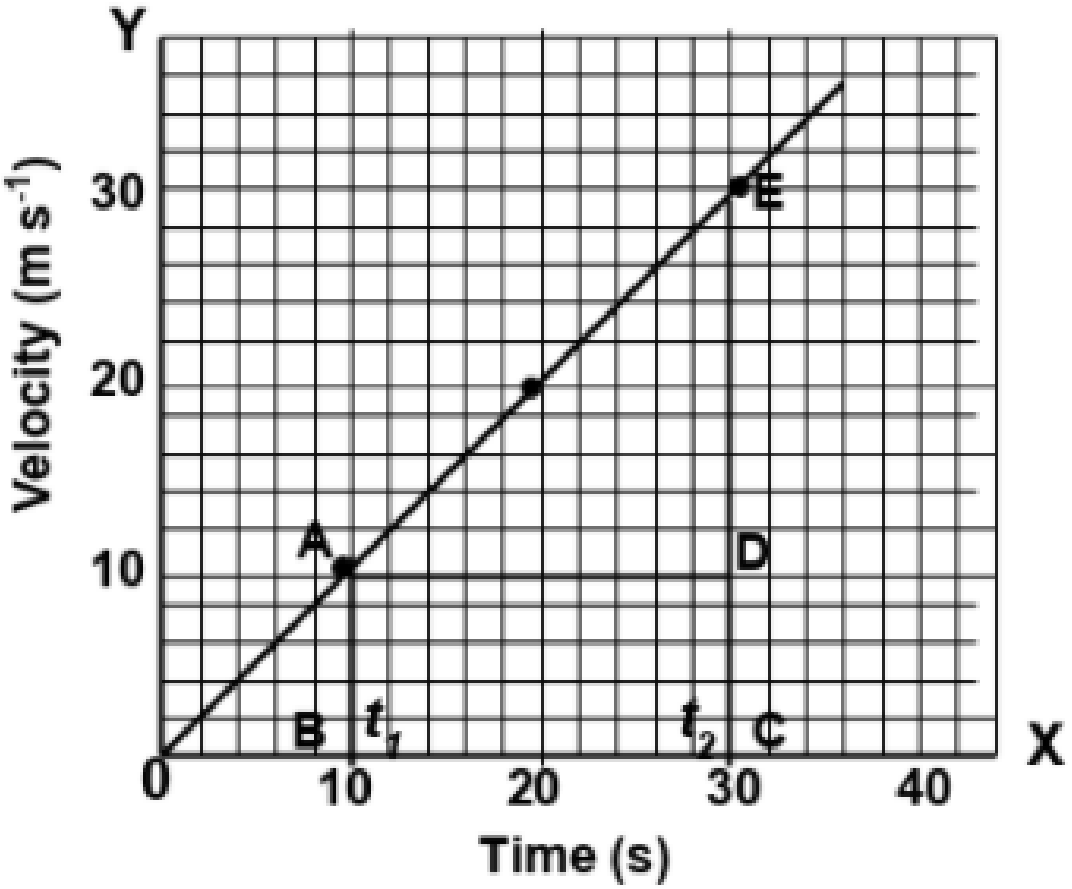


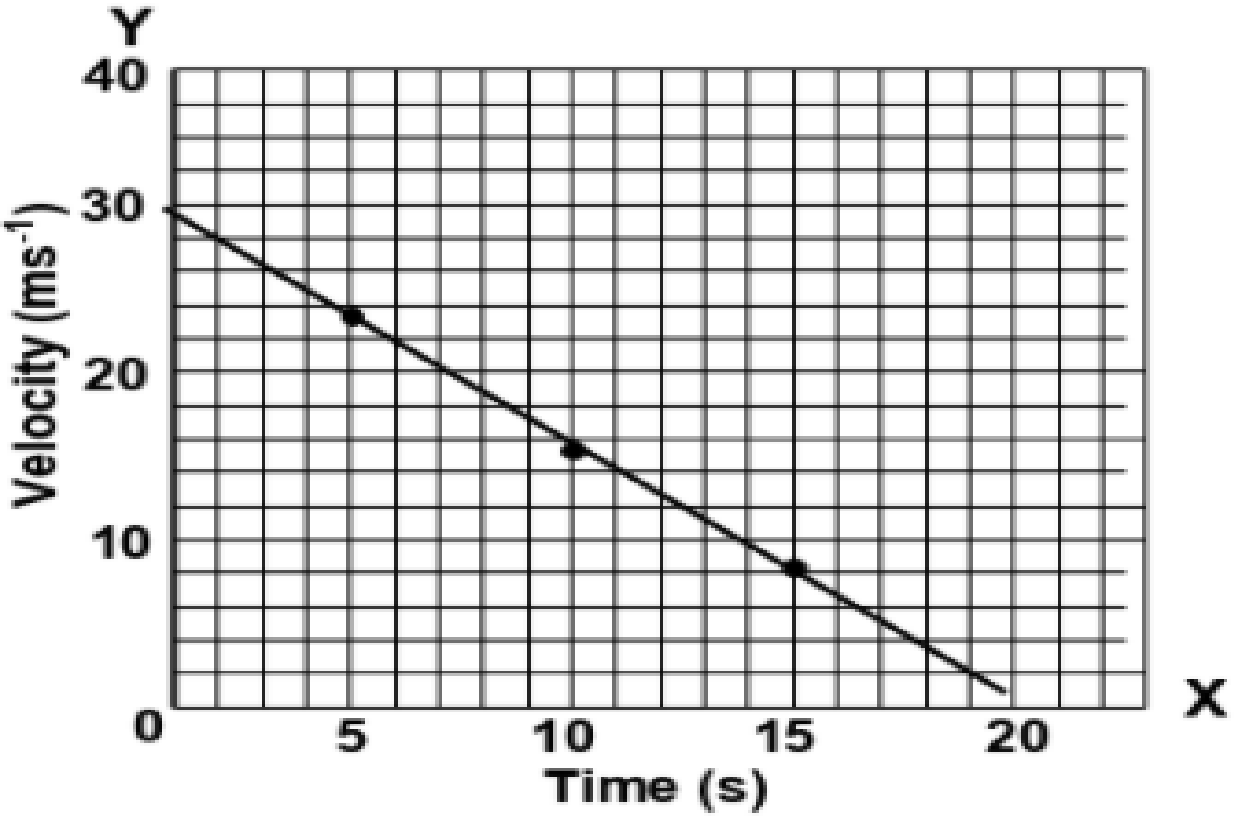
Velocity Time Graphs

- For a body moving with uniform velocity

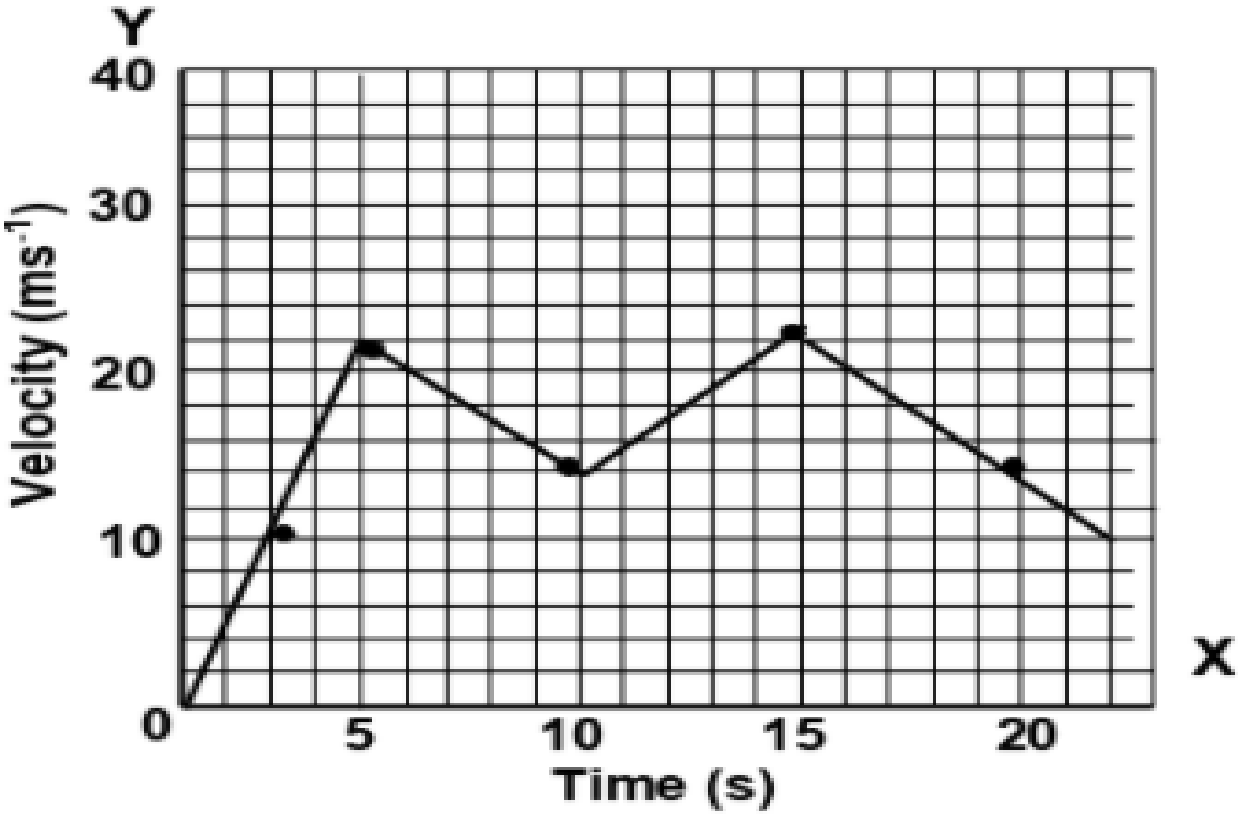


For a body moving with non-uniform acceleration





Velocity – time graph for a uniformly decelerated motion



Velocity – time graph for non uniform acceleration

EQUATIONS OF MOTION

- $V=u+at$ (velocity time relation)
- $S=ut+1/2at^2$(position time relation)
- $V^2-u^2=2as$ (position velocity relation)

Derivation of the first equation of motion

acceleration = $\frac{\text{change in velocity}}{\text{Total time taken}}$

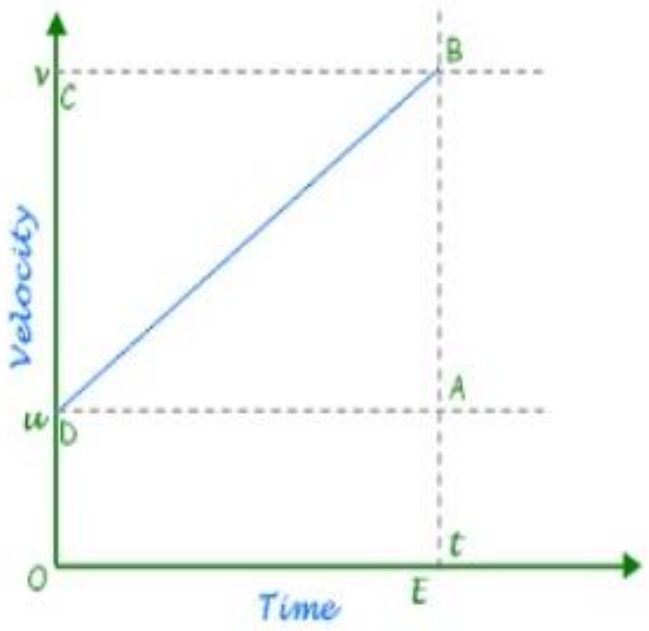
$$a = \frac{BA}{DA}$$

$$a = \frac{CD}{OC}$$

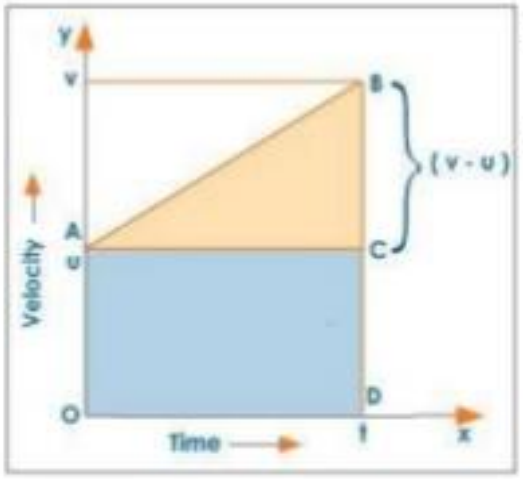
$$a = \frac{OD-OC}{OE}$$

$$a = \frac{V-U}{T}$$

$$V = U + aT$$



Derivation of the second equation of motion



Distance S of DABC = area of the trapezium ABDO = area of rectangle ACDO + area

$$= OD \times OA + \frac{1}{2} BC \times AC$$

$$= t \times u + \frac{1}{2}(v-u) \times t$$

$$= ut + \frac{1}{2}(v-u) \times t$$

$$= t \times u + \frac{1}{2}(v-u) \times t$$

$$= ut + \frac{1}{2}(v-u) \times t$$

$$S = ut + \frac{1}{2} at \times t$$

$$\boxed{S = ut + \frac{1}{2} at^2}$$

Derivation of the first equation of motion

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{Total time taken}}$$

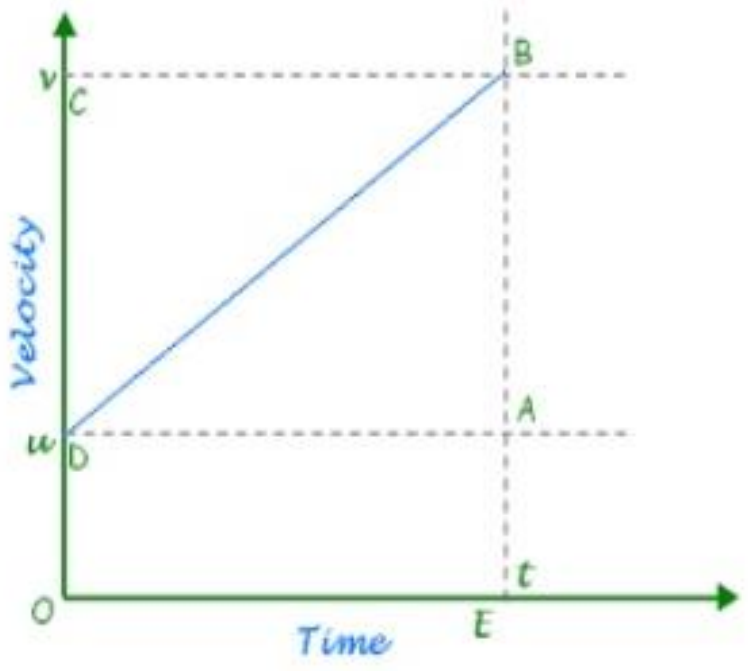
$$a = \frac{BA}{DA}$$

$$a = \frac{CD}{OC}$$

$$a = \frac{OD - OC}{OE}$$

$$a = \frac{V - U}{T}$$

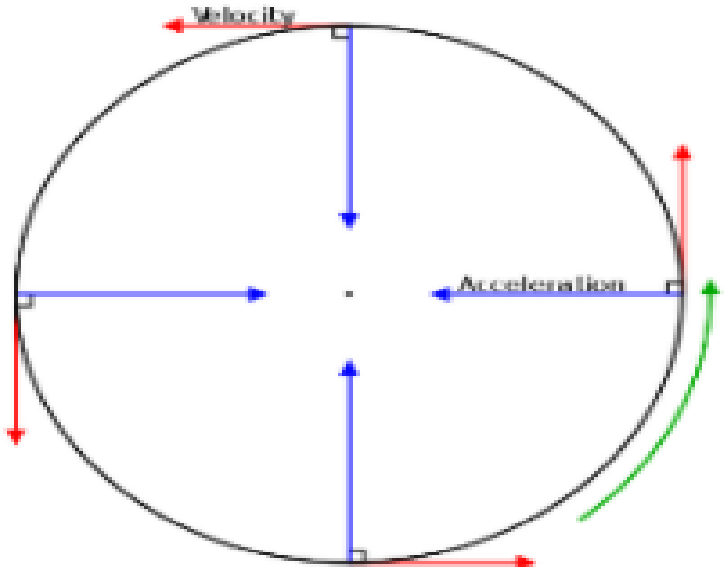
$$V = U + aT$$



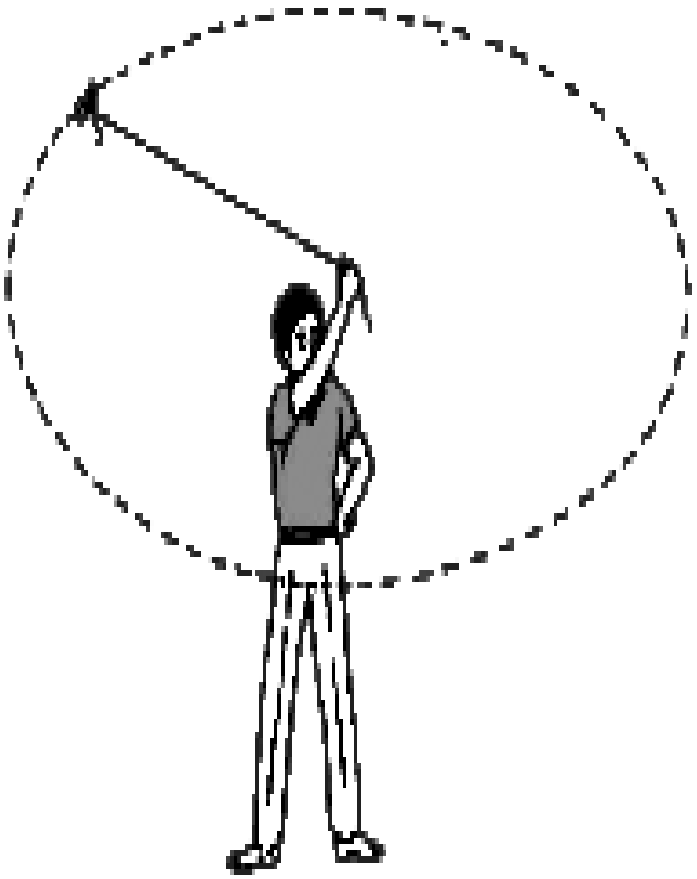
Circular motion

- The motion of a body in a circular path is called a circular motion.
- For a uniform circular motion

$$v = \frac{2\pi r}{t}$$



Acitivity



- Take a piece of thread and tie a small piece of stone at one of its ends. Move the stone to describe a circular path with constant speed by holding the thread at the other end.
- Now, let the stone go by releasing the thread.
- Repeat the activity for a few times by releasing the stone at different positions of the circular path, check whether the direction in which the stone moves remains the same or not.
- OBSERVATION- on being released the stone moves along a straight line tangential to the circular path. This shows that the direction of motion changed at every point when the stone was moving along the circular path.
- Uniform circular motion is an accelerated motion